CHAPTER

FUNDAMENTALS OF CHEMISTRY

MULTIPLE CHOICE QUESTIONS

1. **It is the branch of chemistry which deals with the study of all elements and their compounds except compound of carbon and hydrogen and their derivatives.**
   (a) Organic chemistry (b) Physical chemistry
   (c) Inorganic chemistry (d) Bio chemistry
2. **It provides the identity of substance.**
   (a) Qualitative analysis (b) Analytical analysis
   (c) Quantitative analysis (d) Chemical analysis
3. **It is applicable in chemical industry like metallurgy ceramics and glass**
   (a) Organic chemistry (b) Inorganic chemistry
   (c) Industrial chemistry (d) Nuclear chemistry
4. **Anything which have mass and occupies space is called**
   (a) Substance (b) Matter (c) Element (d) Atomic mass
5. **Which one of the following were known in early ages.**
   (a) Copper (b) Hydrogen (c) Silicon (d) Zinc
6. **Until the end of 19^{th} Century how many elements were discovered**
   (a) 9 (b) 63 (c) 92 (d) 118
7. **percentage of aluminum in crust of earth is**
   (a) 47% (b) 28% (c) 7.8% (d) 1.8%
8. **Which are of the element is liquid at room temperature**
   (a) Bromine (b) Mercury (c) Both (d) None
9. **Piece of matter in pure form is called**
   (a) Mixture (b) Matter (c) Substance (d) Compound
10. **The quantity of potassium magnesium sulphur and sodium in human body is**
    (a) 0.2% (b) 0.6% (c) 0.8% (d) 0.4%
11. **The unique property of an element is called**
    (a) Radical (b) Valency (c) Mixture (d) Symbol
12. **In water fix ratio of hydrogen and oxygen by mass is**
    (a) 8:1 (b) 2:16 (c) 1:8 (d) 2:1
13. **The mixture which have uniform composition through out is called**
    (a) Simple mixture (b) homogeneous mixture
    (c) Heterogeneous mixture (d) Compound mixture
14. **It is the mixture of oxygen, nitrogen and carbon dioxide**
    (a) Soil (b) Water (c) Air (d) Brass

15. **The sum of proton and neutron in the nucleus of atom.**
(a) Atomic number (b) Mass number (c) Formula mass (d) Atomic mass unit

16. **A substance whose atoms have the same atomic number**
(a) Element (b) Substance (c) Mixture (d) Compound

17. **H_3O^+ is a common example of**
(a) Radical cation (b) Radical anion (c) Ion (d) Radical

18. **One mole of any material contain chemical units.**
(a) 6.02×10^{23} (b) 6.02×10^{24} (c) 6.02×10^{-24} (d) 6.02×10^{25}

19. **Ion, molecular ions, free radicals and neutral molecules are called**
(a) Ionic species (b) molecular species (c) Chemical species (d) Atomic species

20. **Noble gasses are the best examples of**
(a) Mono atomic molecules (b) Hetero atomic molecules
(c) Poly atomic molecules (d) Homo atomic molecules

21. **Brass is the mixture of**
(a) Cu+Zn (b) Cu+Pb (c) Zn+Pb (d) Sn+Cu

22. **The molar mass of H_3PO_4**
(a) 58.5g (b) 98g (c) 40g (d) 48g

23. **The number of particles in one mole of substance is called**
(a) Atomic number (b) Particle number (c) Avogadro's number (d) Mass number

24. **1amu=**
(a) 1.66×10^{23}g (b) 1.66×10^{-24}g (c) 1.66×10^{-23}g (d) 6.02×10^{-25}

25. **The sum of atomic masses of all the atoms in one formula unit of a substance**
(a) Atomic mass (b) Mass number (c) Formula mass (d) Atomic mass unit

26. **It shows the simplest whole number ratio of atoms in a substance**
(a) Molecular formula (b) Empirical formula
(c) Chemical formula (d) Covalent formula

27. **Chemical formula of washing soda is**
(a) $Na_2CO_3.H_2O$ (b) $Na_2CO_3.10H_2O$ (c) $Na_2CO_3.7H_2O$ (d) Na_2CO_3

28. **Mass of an electron is**
(a) 5.486×10^{-4}amu (b) 9.106×10^{-28}amu (c) Both a & b (d) None

29. **It is reactive species**
(a) Molecules (b) Molecular ions (c) Compound (d) Formula unit

30. **Atom or group of atom having odd number of electron**
(a) Radical (b) Ion (c) Free radical (d) Molecular ion

31. **It is tri atomic molecule**
(a) H_2SO_4 (b) N_2 (c) CO_2 (d) HCl

32. **The formula mass of an ionic compound expressed in gram is called**
(a) gram formula mass (b) gram formula
(c) Mole (d) All of these

33. Total number of ions in one mole of NaCl

(a) 12.04×10^{23} ions (b) 1.204×10^{23} ions
(c) 6.04×10^{23} ions (d) 61.04×10^{23} ions

34. Number of moles$\times 6.02 \times 10^{23}$=

(a) Number of moles (b) Number of particles
(c) Mass of substance (d) Mass of particles

35. The theory dual nature of matter was put forward by

(a) Dalton (b) New land (c) De Broglie (d) Hanri Backral

36. It is a liquid element at room temperature

(a) Mercury (b) Nickel (c) Hydrogen (d) Iodine

37. Mass of proton is

(a) 1.672×10^{-24}amu (b) 16.72×10^{-24}g (c) 1.672×10^{24}g (d) 1.672×10^{-24}g

38. The number of neutrons in $_{92}U^{238}$

(a) 194 (b) 92 (c) 146 (d) 238

39. An atom of group of atom having positive charge on it is called

(a) Cation (b) Anion (c) Molecule (d) Atom

40. Which of the following shows variable valency

(a) Ca (b) Fe (c) B (d) I

ANSWER KEY

Q.No	Ans	Q.No	Ans	Q.No	Ans	Q.No	Ans	Q.No	Ans	Q.No	Ans	Q.No	Ans
1	c	7	c	13	b	19	C	25	c	31	c	37	d
2	a	8	c	14	c	20	A	26	b	32	d	38	c
3	c	9	c	15	b	21	A	27	b	33	a	39	a
4	b	10	c	16	a	22	B	28	a	34	b	40	b
5	a	11	b	17	a	23	C	29	b	35	c	KIPS	
6	b	12	c	18	a	24	B	30	c	36	a		

SHORT QUESTIONS

1.1 BRANCHES OF CHEMISTRY

Q.1 What is Science?

The knowledge that provide understanding of this world and how its work is science.

Q.2 In which branch of chemistry behavior of gases and liquids is studied?

Ans. Physical chemistry deals with the physical behavior and properties of gases and liquids.

Q.3 Define biochemistry?

Ans. It is branch of chemistry which deals with a structure composition and chemical processes taking place in living organism.

Q.4 Which branch of chemistry deals with preparation of paints and papers?

Ans. The preparation of paints and papers is studied in industrial chemistry.

Q.5 In which branch of chemistry are the metabolic processes of carbohydrates and proteins studied?

Ans. The metabolic processes of carbohydrate and proteins studied in biochemistry.

Q.6 Which branch of chemistry deals with energy of atoms and its , uses in daily life?

Ans. Nuclear chemistry is the branch of chemistry which deals with the energy of atom and its uses in daily life.

Q.7 Which branch of chemistry deals with the structure and properties of naturally occurring molecules?

Ans. Organic chemistry is the branch of chemistry which deals with the structure and properties of naturally occurring molecules.

1.2.1 ELEMENT, COMPOUND AND MIXTURE

Q.1 Can you identify mixture, elements or compound out of the followings: Coca cola, petroleum, sugar, table salt, blood, gun powder, urine, aluminium, silicon, tin, lime and ice cream.

Ans.

Element	Compound	Mixture
Aluminum	Sugar	Petroleum
Silicon	Table salt	Blood
Tin		Gun powder
		Urine
		Ice cream

Q.2 How can you justify that air is a homogenous mixture. Identify substances present in it.

Ans. Air is a homogeneous mixture of nitrogen gas, oxygen gas, carbon dioxide gas, noble gases and moisture. It is homogeneous because the composition of each element of compound is uniform throughout in air.

Q.3 Name the elements represented by the following symbols:

Hg, Au, Fe, Ni, Co, W, Sn, Na, Ba, Br, Bi

Ans.

Symbol	Name	Symbol	Name
Hg	Mercury	Sn	Tin
Au	Gold	Na	Sodium
Fe	Iron	Ba	Barium
Ni	Nickel	Br	Bromine
Co	Cobalt	Bi	Bismuth
W	Tungsten		

Q.4 Name a solid, a liquid and a gaseous element that exits at the room temperature.

Ans.

Solid	Liquid	Gas
Iodine	Bromine	Fluorine
Copper	Mercury	Chlorine
Gold	Germanium	Hydrogen

Q.5 What elements do the following compounds contain?
Sugar, common salt, lime water and chalk.

Ans.

Name of Compound	Formula	Composition
Sugar	$C_6H_{12}O_6$	Carbon (C), Hydrogen (H), Oxygen (O)
Common Salt	NaCl	Sodium (Na), Chlorine (Cl)
Lime water	$Ca(OH)_2$	Calcium (Ca), Oxygen (O), Hydrogen (H)
Chalk	CaO	Calcium (Ca), Oxygen (O)

1.2.4 EMPIRICAL FORMULA AND MOLECULAR FORMULA

Q.1 What is the relationship between empirical formula and formula unit?

Ans.

Empirical Formula	Formula Unit
• It is the simplest whole number ratio of atoms present in a compound.	• The simplest whole number ratio of ions as present in the ionic compound.
• The Empirical formula of $C_6H_{12}O_6$ (glucose) is CH_2O	• The Formula Unit of sodium chloride is NaCl

Q.2 How can you differentiate between molecular formula and empirical formula?

Ans.

Empirical Formula	Molecular Formula
• It is the simplest whole number ratio of atoms present in a compound.	• Molecular formula that show actual number of atoms of each element present in a molecule of that compound.
• The Empirical formula of $C_6H_{12}O_6$ (glucose) is CH_2O	• The molecular formula of glucose is $C_6H_{12}O_6$

Q.3 Identify the following formulae as formulas or unit molecular formulae:
H_2O_2, CH_4, $C_6H_{12}O_6$, $C_{12}H_{22}O_{11}$, $BaCO_3$, KBr

Ans.

Molecular Formula	Formula Unit	Empirical Formula
H_2O_2	$BaCO_3$	$BaCO_3$
CH_4	KBr	KBr
$C_6H_{12}O_6$		CH_4
$C_{12}H_{22}O_{11}$		$C_{12}H_{22}O_{11}$

Q.4 What is empirical formula of acetic acid (CH_3COOH)? Find out is molecular mass

Ans. Empirical formula of acetic acid is CH_2O because the molecular formula of acetic acid is $C_2H_4O_2$

Molecular mass of acetic acid is

$C_2H_4O_2 = 12\times2+1\times4+16\times2$

$= 24+4+32$

$= 60g$

Q.5 Calculate the formula masses of Na_2SO_4, $ZnSO_4$ and $CuCO_3$.

Ans.

$Na_2SO_4 = 23\times2+1\times32+16\times4$

$= 46+32+64$

$= 142g$

$ZnSO_4 = 65\times1+1\times32+16\times4$

$= 65+32+64$

$= 161g$

$CuCO_3 = 63\times1+1\times12+16\times3$

$= 63+12+48$

$= 123g$

1.3 CHEMICAL SPECIES

Q.1 Identify among the followings as diatomic, triatomic or polyatomic molecules H_2SO_4, H_2, CO_2, HCl, CO, C_6H_6, H_2O

Ans.

Diatomic Molecule	Tri-atomic Molecule	Polyatomic Molecule
H_2	CO_2	H_2SO_4
CO	H_2O	C_6H_6
	HCl	

Q.2 Identify among the followings as cation, anion, free radical, molecular ion or molecule: Na^+, $Br^\bullet$, N_2^+, N_2, Cl_2, CO_3^{2-}, H^-, O_2, O^{2-}

Ans.

Cation	Anion	Free radical	Molecular Ion	Molecule
Na^+	H^-	$Br^\bullet$	N_2^+	N_2
	O^{2-}		CO_3^{2-}	O_2
				Cl_2

1.5 AVOGADRO'S NUMBER AND MOLE

Q.1 Which term is used to represent the mass of 1 mole of molecules of a substance?

Ans. Avogadro's number is used to represent the mass of 1 mole of molecules of a substance. It is represented by 'N_A'

Q.2 How many atoms are present in one gram atomic mass of a substance?

Ans. Number of atom $= 6.02 \times 10^{23}$

Q.3 Explain the relationship between mass and mole of a substance.

Ans.

Mass	Mole
The sum of atomic masses of all the atoms present in one molecule of a molecular compound is its molecular mass.	A mole is defined as the amount(mass) of a substance that contains 6.02×10^{23} number of particles (atoms, molecules or formula units).
Example: Molecular mass of water is 18 amu and that of carbon is 44 amu	**Example.** Atomic mass of carbon expressed as 12 g = 1 mol of H_2SO_4

Q.4 Find out the mass of 3 moles of oxygen atoms.

Ans. Number of mole = 3

Mass of oxygen in 1 mole = 16g

Mass of oxygen in 3 moles = 16×3

= 48g

Q.5 How many molecules of water will be present in half mole of water?

Ans. Number of molecule in 1 mole $= 6.02 \times 10^{23}$ molecules

Number of molecule in 0.5 mole $= 6.02 \times 10^{23} \times 0.5$

$= 3.01 \times 10^{23}$ molecules

1.6 CHEMICAL CALCULATION

Q.1 How many atoms of sodium are present in 3 moles of sodium and what is the mass of it?

Ans. Number of atoms in 1 mole of sodium $= 6.02 \times 10^{23}$ atoms

Number of atoms in 3 moles of sodium $= 3 \times 6.02 \times 10^{23}$

$= 18.06 \times 10^{23}$

$= 1.806 \times 10^{24}$ atoms

Mass of 1 sodium atom = 23 gm

Number of atom $= 1.806 \times 10^{24}$

$$\text{Number of atom} = \frac{\text{Mass}}{\text{Molar Mass}} \times 6.02 \times 10^{23}$$

$$\frac{1.806 \times 10^{24}}{1} = \frac{\text{Mass}}{23} \times 6.02 \times 10^{23}$$

$$\text{Mass} \times 6.02 \times 10^{23} = 1.806 \times 10^{24} \times 23$$

$$\text{Mass} = \frac{1.806 \times 10^{24} \times 23}{6.02 \times 10^{23}}$$

Mass=69g

Q.2 How many atoms are in 1 amu and 1 g of hydrogen (H)?

Ans. Atomic Mass of Hydrogen = 1 g

1g of hydrogen $= 6.02 \times 10^{23}$ atoms

Q.3 How many atoms are present in 16 g of O and 8g of S?

Ans.

(a) 16g of oxygen contains number of atoms $= 6.02 \times 10^{23}$

(b) 32g of sulphur contains number of atoms $= 6.02 \times 10^{23}$

8g of sulphur contains number of atoms $= \frac{8g}{6.02 \times 10^{23}}$

Result $= \mathbf{1.505 \times 10^{23}}$ **atoms**

Q.4 Is the mass of 1 mole of O and 1 mole of S same?

Ans. No, the mass of 1 mole of oxygen atom is 16g and mass of 1 mole of sulphur atom is 32g

Q.5 What do you mean by 1 atom of C and 1 gram atom of C?

Ans. 1 atom of carbon = 12amu

1 gram atom of carbon = 12g

Q.6 If 16g of oxygen contains 1 mole of oxygen atoms calculate the mass of one atom of oxygen in grams.

Ans. 16g of oxygen = 1 mol of oxygen = 6.02×10^{23}

Mass of one atom of oxygen = 16 grams

Q.7 How many times is 1 mole of oxygen atom heavier than 1 mole of hydrogen atom?

Ans. One mole of oxygen atom is 16 times heavier than the one mole of hydrogen atom.

Q.8 Why does 10 g nitrogen gas contain the same number of molecules as 10 g of carbon monoxide?

Ans. Number of moles of nitrogen gas $= \dfrac{\text{given mass}}{\text{molar mass of } N_2}$

$= \dfrac{10}{28}$

$= 0.35$ mol

Number of molecules of N $=$ number of mole $\times N_A$

$= 0.35 \times 6.02 \times 10^{23}$

Result $= \mathbf{2.107 \times 10^{23}}$ **molecules**

Number of moles of carbon mono oxide $= \dfrac{\text{given mass}}{\text{molar mass of CO}}$

$= \dfrac{10}{28}$

$= 0.35$ mol

Number of molecules of CO $=$ number of mole $\times N_A$

$= 0.35 \times 6.02 \times 10^{23}$

Result $= \mathbf{2.107 \times 10^{23}}$ **molecules**

LONG QUESTIONS

Q. No. 1 What is chemistry? Write down its merits and demerits.

INTRODUCTION

Chemistry

The branch of science which deals with the composition, structure, properties and reactions of matter is called chemistry.

Facilities of chemistry

The development of science and technology has provided us a lot of facilities in daily life. Imagine the role and importance of petrochemical products, medicines and drugs, soap and detergents, paper and plastics, paints and pigments and insecticides and pesticides which all are fruit of the efforts of chemists.

Treatment of pollution

The development of chemical industry has also generated toxic wastes, contaminated water and polluted air around us, On the other. hand, chemistry also provides knowledge and techniques to improve our health and environment and to explore and conserve the natural resources.

Q. No. 2 Explain the branches of chemistry with scope.

1.1 BRANCHES OF CHEMISTRY

Chemistry is divided into following main branches:

- Physical chemistry
- Organic' chemistry
- Inorganic chemistry
- Biochemistry
- Industrial chemistry
- Nuclear chemistry
- Environmental chemistry
- Analytical chemistry

1.1.1 Physical Chemistry

Physical Chemistry is defined as the branch of chemistry that deals with the relationship between the composition and physical properties of matter along with the changes in them.

Scope

The properties such as structure of atoms or formation of molecules, behavior of gases, liquids and solids and the study of the effect of temperature or radiation on matter.

1.1.2 Organic Chemistry

Organic Chemistry is. the study of covalent compounds of carbon and hydrogen-hydrocarbons and their derivatives.

Scope

Organic chemists determine the structure and properties of these naturally occurring as well as synthesized compounds. Scope of this branch covers petroleum, petrochemicals and pharmaceutical industries.

1.1.3 Inorganic Chemistry

Inorganic chemistry deals with the study of all elements and their compounds except those of compounds of carbon and hydrogen-hydrocarbons and their derivatives.

1.2 BASIC DEFINITIONS

Q. No. 3 What is difference between matter and substance?

1.2a Matter

Matter is simply defined as anything that has mass and occupies space.

Example

- Our bodies as well as all the things around us are examples of matter.
- In chemistry we study all types of matters that can exist in any of three physical states; solid, liquid or gas.

1.2b Substance

A piece of matter in pure form is termed as substance.

OR

Substance has a fixed composition and specific properties or characteristics and also have the same properties.

Types

- Element
- Compound
- Mixture

Example

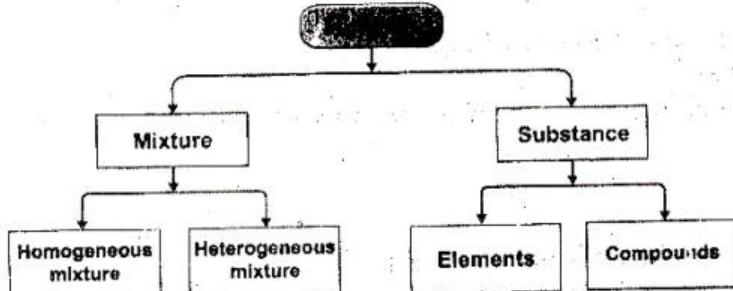
- NaCl
- Sugar
- Water
- Oxygen
- Carbon

Q. No. 4 Explain physical and chemical properties with the help of example.

1.2c Physical Properties

The properties that are associated with the physical state of a matter are called physical properties.

Example

- Colour, smell, taste, hardness, shape of crystal, solubility, melting or boiling points.
- When ice is heated, it melts to form water. When water is further heated, it boils to give steam. In this entire process only the physical state of water changes where as its chemical composition remains the same.

1.2d Chemical Properties

The properties which associated with chemical composition of the matter.

When a substance undergoes a chemical change, its composition changes and a new substance is formed.

Example

Decomposition of water is a chemical change as it produces hydrogen and oxygen gases.

All the materials may either be substance or mixture.

Scope

It has applications in every aspect of the chemical industry such as glass, cement, ceramics and metallurgy (extraction of metals from ores).

1.1. 4 Biochemistry

It is the branch of chemistry in which we study the structure, composition, and . chemical reactions of substances found in living organism.

Scope

- It covers all chemical processes taking place in living organisms. Such as synthesis is and metabolism of bio molecules like carbohydrates, proteins and fats.
- Biochemistry emerged as a separate discipline when scientists began to study how living things obtain energy from food or how' the fundamental biological changes occur during a disease.
- Applications of biochemistry are in the fields of medicine, food science and agriculture.

1.1.5 Industrial Chemistry

The branch of chemistry that deals with the manufacturing of chemical compounds on commercial scale, is called industrial chemistry.

Scope

- It deals with the manufacturing of basic chemicals such as oxygen, chlorine, ammonia, caustic soda, nitric acid and sulphuric acid.
- The chemicals provide the raw materials for many other industries such as fertilizers, soap, textiles, agricultural products, paints and paper etc

1.1.6 Nuclear Chemistry

Nuclear Chemistry is the branch of chemistry that deals with the radioactivity, nuclear processes and properties.

Scope

- The main concern of this branch is with the energy of the atom and its uses in daily life.
- It also includes the study of the chemical effects resulting from the absorption of radiation within living animals, plants, and other materials.
- It has vast applications in medical treatment (radiotherapy), preservation of food and generation of electrical power through nuclear reactors.

1.1.7 Environmental Chemistry

It is the branch of chemistry in which we study about components of the environment and the effects of human activities on the environment.

Scope

- Environmental chemistry is related to other branches like biology, geology, ecology, soil and water chemistry, mathematics and engineering.
- The knowledge of chemical processes taking place in environment is necessary for its improvement and protection against pollution. .

1.1.8 Analytical Chemistry

Analytical chemistry is the branch of chemistry that deals with separation and analysis of a sample to identify its components.

Qualitative analysis

Qualitative analysis provides the identity of a substance (composition of chemical species).

Quantitative analysis

Quantitative analysis determines the amount of each component present in the sample.

Scope

- In this branch different techniques and instruments used for analysis are studied.
- The scope of this branch covers food, water, environmental and clinical analyses.

Q. No. 5 **Write a complete note on elements.**

1.2.1 ELEMENTS, COMPOUNDS AND MIXTURES

1.2.1.1 ELEMENTS

Concept of element

- In the early ages, only nine elements (carbon, gold, silver, tin, mercury, lead, copper, iron and sulphur) were known.
- At that time it was considered that elements were the substances that could not be broken down into simpler units by ordinary chemical process. Until the end of nineteenth century sixty-three elements had been discovered.
- Now 118 elements have been discovered, out of which 92 are naturally occurring elements.

Modern definition of element

It is a substance made up of same type of atoms, having same atomic number and it cannot be decomposed into simple substances by chemical means.

Occurrence

Elements occur in nature in free or combined form. All the naturally occurring elements found in the world have different percentages in the earth's crust, oceans and atmosphere.

TABLE 1.1 NATURAL OCCURRENCES BY WEIGHT % OF SOME MAJOR ELEMENTS

Crust of Earth		Oceans		Atmosphere	
Oxygen	47%	Oxygen	86%	Nitrogen	78 %
Silicon	28 %	Hydrogen	11%	Oxygen	21%
Aluminum	7.8 %	Chlorine	1.8 %	Argon	0.9%

Physical states of elements:

Elements may be solids, liquids or gases.

(i) **Solids**

Majority of the elements exist as solids

Example

Sodium, copper, zinc, gold

(ii) **Liquid**

There are very few elements which occur in liquid state

Example

Mercury and bromine

(iii) **Gases:**

A few elements exist as gases

Example

Nitrogen, oxygen, chlorine and hydrogen.

Classification of element

On the basis of their properties, elements are divided into:

- Metals
- Non-metals
- Metalloids.

About 80 percent of the elements are metals.

DO YOU KNOW

- Major part of the body is made up of water i.e. 65% to 80% by mass.
- Six elements constitute about 99% of our body mass, namely: Oxygen 65 %. Carbon 18%, Hydrogen 10 %, Nitrogen 3%, Calcium 1.5% and Phosphorus 1.5%.
- Potassium, Sulphur, Magnesium and Sodium constitute 0.8% of our body mass. Whereas Copper, Zinc, Fluorine, Chlorine, Iron, Cobalt and Manganese constitute only 0.2% of our body mass.

Q. No. 6 Define the symbol. How symbol can be assigned?

1.2.e Symbol

The elements are represented by symbols, which are abbreviations for the name of elements.

- A symbol is taken from the name of that element in English, Latin, Greek or German.
- If it is one-letter, it will be capital as H for Hydrogen, N for Nitrogen, and C for Carbon
- In case of two letters symbol, only first letter is capital.
- Ca for Calcium, Na for Sodium and C*l* for Chlorine.

Q. No. 7 Define valency. How will you differentiate between valency of ionic compound and covalent compound?

1.2.f Valency

The unique property of an element is Valency. It is combining capacity of an element with other elements. It depends upon the number of electrons in the outermost shell.

Valency of covalent compounds

In simple covalent compounds it is the number of hydrogen atoms which will combine with one atom of that element or a number of bonds formed by one atom of the element. Different numbers of atoms of hydrogen combine with one atom of these elements to form compounds.

Example

HCl, H_2O, NH_3, CH_4

Symbol	Valency
• C*l*	−1
• O	−2
• N	−3
• C	−4

Valency of ionic compounds

In simple ionic compounds Valency is the number of electrons gained or lost by an atom of an element to complete its octet.

(i) Elements having less than four electron valence shell

Elements having less than four electrons in the valence shell, prefer to lose the electrons to complete their octet.

Example

- Na +1
- Mg +2
- Al +3

They lose these electrons to have Valency of 1,2 and 3 respectively.

(ii) Elements having more than four electrons valence shell

Elements having four or more than four electrons in their valence shell, gain electrons tc complete their octet.

Example

Nitrogen , Oxygen and Chorine have 5,6 and 7 electrons in their valence shells respectively They gain 3, 2 and 1 number of electrons respectively to complete their octet. Hence they show valency of 3, 2 and 1 respectively.

- N -3
- O -2
- Cl -1

VALENCIES OF SOME COMMON ELEMENTS AND RADICALS

Table 1.2 Some Elements and Radicals with their Symbols and Common Valencies

Element / Radical	Symbol	Valency	Element / Radical	Symbol	Valency
Sodium	Na	+1	Hydrogen	H	+1,-1
Potassium	K	+1	Chlorine	Cl	-1
Silver	Ag	+1	Bromine	Br	-1
Magnesium	Mg	+2	Iodine	I	-1
Calcium	Ca	+2	Oxygen	0	-2
Barium	Ba	+2	Sulphur	S	-2
Zinc	Zn	+2	Nitrogen	N	-3
Copper	Cu	+1,+2	Phosphorus	P	-3,+5
Mercury	Hg	+1,+2	Boron	B	+3
Iron	Fe	+2,+3	Arsenic	As	+3
Aluminium	Al	+3	Carbon	C	+4,-4
Chromium	Cr	+3	Carbonate	CO_3^{2-}	-2
Ammonium	NH_4^+	+1	Sulphate	SO_4^{2-}	-2
Hydronium	H_3O^+	+1	Sulphite	SO_3^{2-}	-2
Hydroxide	OH^-	-1	Thiosulphate	$S_2O_3^{2-}$	-2
Cyanide	CN^-	-1	Nitride	N^{3-}	-3
Bisulphate	HSO_4^-	-1	Phosphate	PO_4^{3-}	-3
Bicarbonate	HCO_3^-	-1	Bisulphite	HSO_3^{1-}	-1

Q. No. 8 What is variable valency? Explain with the help of example.

Variable Valency

Some elements show more than one valency, they have variable valency.

Example

- Ferrous sulphate ($FeSO_4$) the valency of iron is 2.
- Ferric sulphate ($Fe_2(SO_4)_3$) the valency of iron is 3.

Note

Generally, the Latin or Greek name for the element (e.g., Ferrum) is modified to end in 'ous' for the lower valency (Ferrous = +2) and to end in 'ic' for the higher valency (Ferric=+3).

Q. No. 9 Describe the compound. How it is classified?

1.2.1.2 COMPOUND

Definition

Compound is a substance made up of two or more elements chemically combined together in a fixed ratio by mass.

Properties

- In compounds, elements lose their own properties and produce new substances (compounds) that have entirely different properties.
- Compounds can't be broken down into its constituent elements by simple physical methods.
- Elements chemically combine together in a fix ratio by mass and form compound.
- All compounds is identified by a simple chemically formula

Example

- Carbon dioxide is formed when elements of carbon and oxygen combine chemically in a fixed ratio of 12:32 or 3:8 by mass.
- Water is a compound formed by a chemical combination between hydrogen and oxygen in a fixed ratio of 1:8 by mass.

Classification

Compounds can be classified into two different classes

- Ionic compound
- Covalent compound

Ionic compounds

- Ionic compound do not exist in independent molecular form.
- They form a three-dimensional crystal lattice, in which each ion is surrounded by oppositely charged ions.
- The oppositely charged ions attract each other very strongly, as a result ionic compounds have high melting and boiling points.
- These compounds are represented by formula units

Example

- $NaCl$
- KBr
- $CuSO_4$

TABLE 1.3 SOME COMMON COMPOUNDS WITH THEIR FORMULAE

Compound	Chemical Formula
Water	H_2O
Sodium chloride (Common salt)	$NaCl$
Silicon dioxide (Sand)	SiO_2
Sodium hydroxide (Caustic Soda)	$NaOH$
Sodium carbonate (Washing Soda)	$Na_2CO_3.10H_2O$
Calcium oxide (Quick Lime)	CaO
Calcium carbonate (Lime Stone)	$CaCO_3$
Sugar	$C_{12}H_{22}O_{11}$
Sulphuric acid	H_2SO_4
Ammonia	NH_3

Covalent compounds

- The Covalent compound mostly existence in molecular form.
- A molecule is a true representative of the covalent compound and its formula is called molecular formula

Example

- H_2O
- HCl
- H_2SO_4
- CH_4,

REMEMBER

Always use:

Standard symbols of elements
Chemical formulas of compounds
Proper abbreviations of scientific terms
Standard values and SI units for constants

Q. No. 10 What is mixture? Explain its type in detail.

1.2.1.3 MIXTURE

Definition

When two or more elements or compounds mix-up physically without an)' fixed ratio, they form a mixture.

Properties

- The component substances retain their own chemical identities and properties,
- The mixture can be separated into parent components by physical methods such as distillation, filtration, evaporation, precipitation or magnetization.
- Mixtures that have uniform composition throughout arc' called homogeneous mixtures

TYPES OF MIXTURE

Homogeneous Mixtures

Mixture that have uniform composition through out is called homogenous mixture.

Example

- Air
- Gasoline
- Ice cream

Heterogeneous Mixtures

Mixture that have not uniform composition through out is called heterogeneous mixture.

Example

- Soil
- rock
- Wood

DO YOU KNOW

Air is a mixture of nitrogen oxygen, carbon dioxide, noble gases and moisture.
Soil is a mixture of sand, clay, mineral salts, water and air.
Milk is a mixture of calcium, water, sugar, fat, proteins, mineral salts and vitamins
Brass is a mixture of copper and zinc metals

Q. No. 11 What is difference between compound and mixture?

DIFFERENCE BETWEEN A COMPOUND AND A MIXTURE

Compound	Mixture
• It is formed by a chemical combination of atoms of elements.	• Mixture is formed by the simple mixing up of the substances.
• The constituents lose their identity and form a new substance having entirely different properties from them.	• Mixture shows the properties of the constituents.
• Compounds always have fixed composition by mass.	• The minimum number and ratio of the components may not be fixed.
• The components cannot be separated by physical means.	• The components can be separated by simple physical methods.
• Every compound is represented by a chemical formula.	• It consists of two or more components and does not have any chemical formula.
• Compounds have homogeneous composition.	• They may be homogeneous or heterogeneous in composition
• A compound has a sharp and fixed melting point.	• A mixture does not have a sharp and fixed melting point.

1.2.1 ATOMIC NUMBER AND MASS NUMBER

Q. No. 12 Define atomic number. Explain with the help of example.

Atomic Number

The atomic number of an element is equal to the number of protons present in the nucleus of its atoms.

Representation

It is represented by symbol 'Z'.

Note: As all atoms of an element have the same number of protons in their nuclei, they have the same atomic number.

Explanation

Hence each element has a specific atomic number termed as its identification number. For example, all hydrogen atoms have 1 proton, their atomic number Z=1. All atoms in carbon have 6 protons, their atomic number Z=6. Similarly, in oxygen all atoms have 8 protons having atomic number Z=8 and sulphur having16 protons show atomic number Z=16.

Q. No. 15 Explain the Relative atomic mass and atomic mass unit.

1.2.3 RELATIVE ATOMIC MASS AND ATOMIC MASS UNIT

Relative Atomic Mass

The relative atomic mass of an element is the average mass of atoms of that element as compared to $\frac{1}{12}$ (one-twelfth) the mass of one atom of carbon12 isotope

Isotope

An element having different mass number but same atomic number.

Explanation

The mass of an atom is too small to be determined practically. However, certain instruments enable us to determine the ratio of the atomic masses of various elements to that of carbon-12 atoms. This ratio is known as the relative atomic mass of the elements based on carbon-12 Standard; the mass of an atom of carbon is 12 and 1/12th of it comes to be one. When we compare atomic masses of other elements with carbon-12 atoms, they are expressed as relative atomic masses of those elements.

Unit

The unit for relative atomic masses is called atomic mass unit.

Symbol

Atomic mass unit (amu).

Atomic mass unit

One atomic mass unit is 12th the mass of one atom of carbon-12th

Atomic mass unit is expressed in grams.

1 amu = 1.66×10^{-24} g

Example

- Mass of a proton = 1.0073 amu or 1.672×10^{-24}g
- Mass of a neutron = 1.0087 amu or 1.674×10^{-24}g
- Mass of an electron = 5.486×10^{-4} amu. or 9.106×10^{-28} g

Q. No. 16 Define the chemical formula. Write down the steps to write chemical formula.

1.2 HOW TO WRITE A CHEMICAL FORMULA

Definition

The combination of symbols which represent the elemental composition of a substance is called chemical formula.

Steps

- Symbols of two elements are written side-by-side, in the order of positive ion first and negative ion later.
- The valency of each ion is written on the right top corner of its symbol, e.g. Na^+, Ca^{2+},Cr^{3+} and O^{2-}.
- This valency of each ion is brought to the lower right corner of other ion D 'cross-exchange' method.
- If the valencies are same, they are offset and are not written in the chemical formula. But if they are different, they are indicated as such at the same position
- In case of sodium chloride both the valencies are offset and formula is written as NaCl, whereas, calcium chloride is represented by formula$CaCl_2$.
- If an ion is a combination of two or more atoms which is called radical, bearing net charge on it.

Q. No. 19 What is molecular formula? Write down the relationship between molecular and empirical formula.

1.2.4.2 MOLECULAR FORMULA

Definition

These molecules are represented by molecular formulae that show actual number of atoms of each element present in a molecule of that compound.

Relationship between molecular formula and empirical formula

Molecular formula is derived from empirical formula by the following relationship:

Molecular formula = $(\text{Empirical formula})_n$

Where n is 1,2,3 and so on.

$$n = \frac{\text{molecular formula mass}}{\text{empirical formula mass}}$$

Example

Molecular formula of benzene is C_6H_6 which is derived from the empirical formula CH where the value of n is 6. The molecular formula of a compound may be same or a multiple of the empirical formula.

A few compounds having different empirical and molecular formulae.

COMPOUNDS WITH THEIR EMPIRICAL AND MOLECULAR FORMULAE

Compound	Empirical formula	Molecular formula
Hydrogen peroxide	HO	H_2O_2
Benzene	CH	C_6H_6
Glucose	CH_2O	$C_6H_{12}O_6$

Note

Some compounds may have same empirical and molecular formula

- Water (H_2O)
- hydrochloric acid (HCl)

Q. No. 20 What is difference between Molecular mass and formula mass?

1.2.5 MOLECULAR MASS AND FORMULA MASS

(i) Molecular Mass

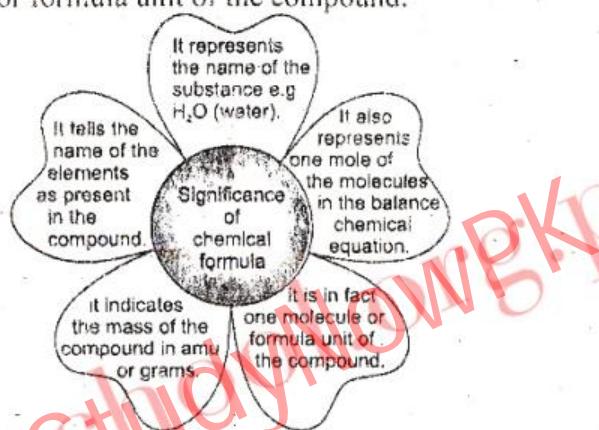
The sum of atomic masses of all the atoms present in one molecule of a molecular compound is its molecular mass.

Example

Molecular mass of water (H_2O) is 18 amu and that of carbon oxide (CO_2) is 44 amu

EXAMPLE: 1.2

Calculate the molecular mass of Nitric acid, HNO_3

Atomic mass of H = 1 amu
Atomic mass of N = 14 amu
Atomic mass of O = 16 amu
Molecular formula = HNO_3
= (At. mass H)+(At. mass N) + 3 (At. Mass O)
= 1 + 14 + 3(16)
= 63 amu

Example

- SO_4^{2-} (sulphate ion) and PO_4^{3-} (phosphate ion)the net charge represent the valency of radical in these cases writing the radical with in the parenthesis.
- Aluminum sulphate is written as $Al_2(SO_4)_3$
- Calcium phosphate as $Ca_3(PO_4)_2$.

Q. No. 17 Write down the significance of chemical formula.

Significances of chemical formula

- It represents the name of the substance e.g., H_2O (water)
- It tells the name of the elements as present in the compound.
- It indicates the mass of the compound in amu or grams.
- It also represents one mole of the molecule in the balance chemical equation.
- It is in fact one molecule or formula unit of the compound.

Q. No. 18 Define the empirical formula. Describe the empirical formula of ionic compound and covalent compound.

1.2.4.1 EMPIRICAL FORMULA

Definition

The simplest type of formula empirical formula. It is the simplest whole number ratio of atoms present is compound.

Empirical formula of covalent compound

The covalent compound silica (sand) has simplest ratio of 1:2 of silicon and oxygen respectively. Therefore, its empirical formula is SiO_2. Similarly, glucose has simplest ratio 1:2:1 of carbon, hydrogen and oxygen respectively. Hence its empirical formula is CH_2O.

Empirical formula of ionic compound

As discussed earlier, the ionic compounds exist in three dimensional network forms. Each ion is surrounded by oppositely charged ions in such a way to electrically neutral compound. Therefore, the simplest unit taken as a represent an of an ionic compound is called formula unit.

Formula unit

The simplest whole number ratio of ions, as present in the ionic compound. In other words, ionic compounds have only empirical formulae.

Example

- Formula unit of common consists of one Na^+ and one Cl^- ion and its empirical formula is NaCl.
- Formula unit of potassium bromide is KBr, which is also its empirical formula

(ii) Formula Mass

Some ionic compounds that form three-dimensional solid crystal, are represented by their formula units. Formula mass in such cases is the sum of atomic Solution.

Example

- formula mass of sodium chloride is 55.5 amu
- formula mass of calcium carbonate is 100 amu

1.3 CHEMICAL SPECIES

Q. No. 21 Define an ion. Write down its type.

1.3.1 Ions (Cations and Anions), Molecular Ions and Free Radicals

Ion

Ion is an atom or group of atoms having a charge on it. The charge may be positive or negative.

Types

There are two types of ions

- Cations
- Anions

Cation

Atom or group of atoms having positive charge on it is called cation.

Formation

The cations are formed when an atom loses electrons from its outermost shells.

Example

- Na+
- K+

Equation

The following equations show the formation of cations from atoms.

Atoms		Cations
H	$\longrightarrow$	$H^+ + 1e^-$
Na	$\longrightarrow$	$Na^+ + 1e^-$
Ca	$\longrightarrow$	$Ca^{2+} + 2e^-$

Anion

An atom or a group of atoms that has a negative charge on it, is called anion.

Formation

Anion is formed by the gain or addition of electrons to an atom.

Example

- Cl^{1-}
- O^{2-}
- H^{1-}

Equation

Following examples show the formation of an anion by addition of electrons to an atom.

Atoms		Anions
$H + 1e^-$	$\longrightarrow$	H^-
$Cl + 1e^-$	$\longrightarrow$	Cl^-
$O + 2e^-$	$\longrightarrow$	O^{2-}

Q. No. 22 What is molecular ion? Write down its types.

1.3.1.1 MOLECULAR ION

Definition

When a molecule losses or gains an electron, it forms a molecular ion, a molecular ion or radical is a species having positive or negative charge on it.

Types

- Cationic molecular ion
- Anionic molecular ion

Cationic molecular ion

The molecular ion form by losing of electron are called cationic molucalar ion.

Example

- N_2^+
- He^+
- CH_4^+

Anionic molecular ion

The molecular ion form by gaining of electron are called anioinic molucalar ion.

Example

- N_2^-
- O_2^{-2}
- SO_4^{-2}
- PO_4^{-3}

Note

Cationic molecular ions are more abundant than anionic molecular ions)

Formation

When gases are bombarded with high-energy electrons in a discharge tube, they ionize to give molecular ions)

Q. No. 22 Define the free radical. How it is formed?

1.3.1.2 FREE RADICALS

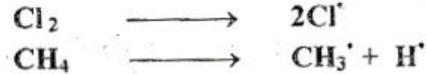
Definition

Free radicals are atoms or group of atoms possessing odd number of (unpaired) electron.

Representation

It is represented by putting a dot over the symbol of an element.

Example

- $Cl^{\bullet}$
- $H^{\bullet}$
- $OH^{\bullet}$
- $CH_3^{\bullet}$

Formation

Free radicals are generated by the hemolytic (equal) breakage of the bond between two atoms when they absorb heat or light energy.

Reactivity

A free radical is extremely reactive species as it has the tendency to complete its octet.

Equation

$$Cl_2 \longrightarrow 2Cl^{\bullet}$$

$$CH_4 \longrightarrow CH_3^{\bullet} + H^{\bullet}$$

Q. No. 23 What is difference between ions and free radicals?

DIFFERENCE BETWEEN IONS AND FREE RADICALS

Ions	Free Radicals
• These arc the atoms which bear some charge	• These are the atoms that have odd number of electrons
• They exist in solution or in crystal Lattice	• They can exist in solutions as well in air
• Their formation is not affected by the presence of light	• They may form in the presence of light

Q. No. 24 What is difference between molecule and molecular ion?

DIFFERENCE BETWEEN MOLECULE AND MOLECULAR ION

Molecule	Molecular Ion
• It is the smallest particle of a compound which can exist independently and shows all the properties of that compound	• It is formed by gain or loss of electrons by a molecule
• It is always neutral	• It can have negative or positive charge
• It is formed by the combination of atoms	• It is formed by the ionization of a molecule
• It is a stable unit	• It is a reactive specie

Q. No. 24 What is difference between atoms and ions?

DIFFERENCE BETWEEN ATOMS AND IONS

Atom	Ion
• It is the smallest particle of an element.	• It is the smallest unit of an ionic compound.
• It can or cannot exist independently and can take part in a chemical reaction.	• It cannot exist independently and is surrounded by oppositely charged ions.
• It is electrically neutral	• It has a net charge (either negative or positive) on it.

Q. No. 25 Explain the classification of molecules with examples.

1.3.2 TYPES OF MOLECULES

Molecule

A molecule is formed by the chemical combinations of atoms.

Properties

- It is the smallest unit of a substance.
- It shows all the properties of the substance and can exist independently.
- There are different types of molecules depending upon the number and types of atoms combining.

TYPES

(i) Monoatomic Molecule

A molecule consisting of only one atom is called mono atomic molecule.

Example

The inert gases helium, neon and argon all exist independently in atomic form and they are called mono atomic molecules.

(ii) Diatomic Molecules

If a molecule consists of two atoms it is called diatomic.

Example

- Hydrogen (H_2)
- Oxygen (O_2)
- Chlorine (Cl_2)
- Hydrogen chloride (HCl)

(iii) Triatomic molecules:

I it consists of three atoms. it is called triatomic.

Example

- H_2O
- CO_2

(iv) Polyatomic Molecules

If a molecule consists of many atoms it is called polyatomic.

Example

- Methane (CH_4)
- Sulphuric acid (H_2SO_4)
- Glucose ($C_6H_{12}O_6$).

(v) Homoatomic Molecule

A Molecule containing same type of atoms is called homoatomic molecule.

Example

- Hydrogen (H_2)
- Ozone (O_3),
- Sulphur (S_8)
- Phosphorus (P_4)

(vi) Hetroatomic Molecule

When a molecule consists of different kinds of atoms, it is called hetroatomic molecule.

Example

- CO_2
- H_2O
- NH_3

Q. No. 26 What are gram atomic mass, gram molecular mass and gram formula mass?

1.4 GRAM ATOMIC MASS, GRAM MOLECULAR MASS AND GRAM FORMULA MASS

(i) Gram Atomic Mass

The atomic mass of an element expressed in grams is called gram atomic mass or gram atom. It is also called a mole

Example

- 1 gram atom of hydrogen = 1.008 g = 1 mol of hydrogen
- 1 gram atom of carbon = 12.0 g = 1 mol of carbon

(ii) Gram Molecular Mass

The molecular mass of an ionic compound expressed in grams is called gram molecular mass. or gram molecule. It is also called a mole.

Example

- 1 gram molecule of, water = 18.0 g = 1 mol of water
- 1 gram molecule of H_2SO_4 = 98.0 g = 1 mol of sulphuric acid

(iii) Gram Formula Mass

The formula mass of an ionic compoundexpressed in grams is called gram Formula mass or gram formula this is also called a mole.

Example

- 1 gram formula of NaCl = 58.5 g = 1 mol of sodium chloride
- 1 gram formula of $CaCO_3$ = 100 g = 1 mol of calcium carbonate

1.5 AVOGADRO'S NUMBER AND MOLE

Q. No. 27 Explain the Avogadro's number.

AVagadro's Number

Introduction

In chemistry we deal with substances which are composed of atoms, molecules or formula units. The counting of these particles is not possible for the chemists. The concept of Avogadro's number facilitated the counting of particles contained in the given mass of a substance. Avogadro's number is a collection of 6.02×10^{23} particles.

Definition

The 6.02×10^{23} number of atoms, molecules or formula units are called Avogadro's number that is equivalent to one 'mole' of respective substance.

Representation

It is represented by symbol 'N_A'.

Explanation

In simple words 6.02×10^{23} particles are equal to one mole as twelve eggs are equal to one dozen. To understand the relationship between the Avogadro's number and the mole of a substance.

Example

- 6.02×10^{23} atoms of carbon are equivalent to one mole of carbon.
- 6.02×10^{23} molecules of H_2O are equivalent to one mole of water.
- 6.02×10^{23} formula units of NaCl are equivalent to one mole of sodium chloride.

Definition

Thus, 6.02×10^{23} atoms of elements or 6.02×10^{23} molecules of molecular compounds or 6.02×10^{23} formula units of ionic compounds are equivalent to 1 mole.

Explanation with examples

For further explanation about number of atoms in molecular compounds or number of ions in ionic compounds let us discuss two examples:

- One molecule of water is made up of 2 atoms of hydrogen and 1 atom of oxygen, hence 2 × 6.02×10^{23} atoms of hydrogen and 6.02×10^{23} atoms of oxygen constitute one mole of water.
- One formula unit of sodium chloride consists of one sodium ion and one chloride ion. So there are 6.02×10^{23} number of Na^+ ions and 6.02×10^{23} Cl^- ions in one mole of sodium chloride. Thus, the total number of ions in 1 mole of NaCl is 12.04×10^{23} or 1.204×10^{24}.

Q. No. 28 Define the mole. How mole is helpful for the calculation of particles.

1.5.2 MOLE (CHEMIST SECRET UNIT)

Definition

A mole is defined as the amount (mass) of a substance that contains 6.02×10^{23} number of particles (atoms, molecules or formula units).

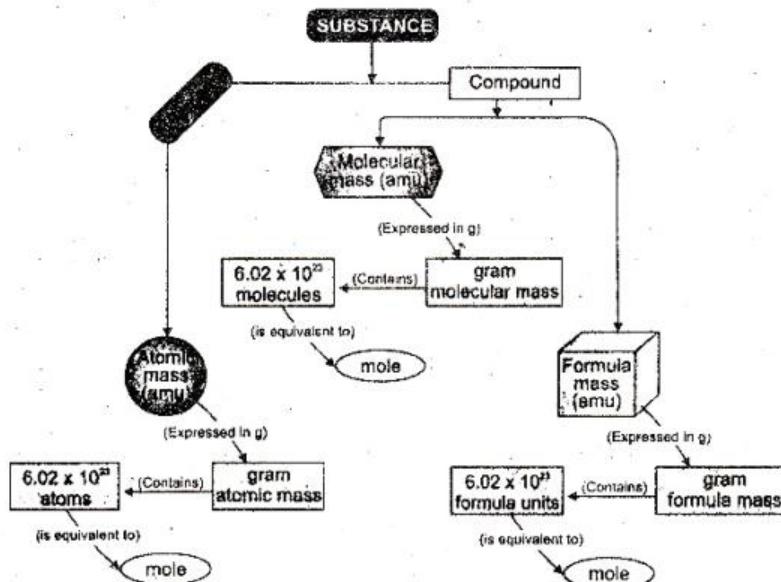
Symbol

It is abbreviated as 'mol.

Explanation

Mass of a substance is either one of the following: atomic mass, molecular mass or formula mass. These masses are expressed in atomic mass units (amu). But when these masses are expressed in grams, they are called as molar masses or molar mass of a substance.

Quantitative definition of mole

It is the atomic mass, molecular mass or formula mass of a substance expressed in grams is called mole.

Example

- Atomic mass of carbon expressed as 12 g = 1 mol of H_2SO_4
- Molecular mass of H_2O expressed as 18 g = 1 mol of NaCl
- Molecular mass of H_2SO_4 expressed as 98 g = 1 mol of carbon
- Formula mass of NaCl expressed as 58.5 g = 1 mol of water

Relationship between mole and mass

$$\text{Number of moles} = \frac{\text{known mass of substance}}{\text{molar mass of substance}}$$

Mass of substance (g) = number of moles x molar mass

Example 1.4

Calculate the gram molecule (number of moles) in 40 g of H_3PO_4.

Solution

Given mass of H_3PO_4 = 40g

Molecular mass of H_3PO_4 = $98 gmol^{-1}$

Putting these values in equation

$$\text{Number of gram molecule (mol)} = \frac{\text{mass of substance}}{\text{molar mass of substance}}$$

$$= \frac{48}{98}$$

$$= 0.408 \text{ g}$$

Therefore, 40 grams will contain 0.408 gram molecule of H_3PO_4

Q. No. 29 Explain in detail the chemical calculation. Write down formulas related to chemical calculation.

1.6 CHEMICAL CALCULATIONS

Definition

Calculating the number of moles and number of particles from known mass of a substance.

First calculate the number of moles from given mass by using equation

$$\text{Number of Moles} = \frac{\text{Known mass of substance}}{\text{Molar mass of substance}}$$

1.6.1 Mole-Mass Calculations

In these calculations, we calculate the number of moles of a substance from the known mass of the substance with the help of following equation:

$$\text{Number of Moles} = \frac{\text{Known mass of substance}}{\text{Molar mass of substance}}$$

When we rearrange the equation to calculate mass of a substance from the number of moles of a substance we get,

mass of substance (g) = number of moles x molar mass(g)

$$\text{Number of moles} = \frac{\text{mass of substance}}{\text{molar mass of substance}}$$

EXAMPLE 1.5

[illegible] a piece of coal (carbon) weighing 9.0 gram. Calculate the number of mol of coal in the given mass.

Solution

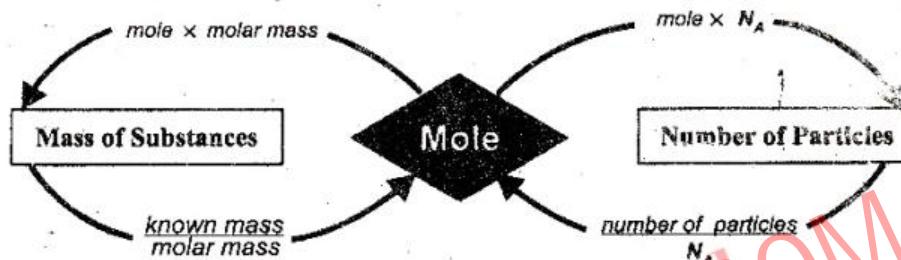
The mass is converted to the number of moles by the equation:

$$\text{Number of Moles} = \frac{\text{Known mass of substance}}{\text{Molar mass of substance}}$$

$$= \frac{9}{12} = .75$$

So, 9 g of coal is equivalent to 0.75 mol.

1.6.2 Mole-Particle Calculations

In these calculations we can calculate the number of moles of a substance from the given number of particles or vice versa. The particles are the atoms, molecules or formula units.

$$\text{Number of moles} = \frac{\text{given number of particles}}{6.02 \times 10^{23}}$$

On rearranging this equation we get,

- Number of particles = number of moles x 6.02×10^{23}

Then calculate number of particles from the calculated with the help of following equation:

Number of particles = number of moles x 6.02×10^{23}

Q. No. 30 Explain the molecularity if physical world.

THE MOLECULARITY OF THE PHYSICAL WORLD.

The nature of the physical world as perceived through men's senses has been investigated depth. The biggest lesson we learnt in 20th century is that Chemistry has become central science. It leads to the discovery of every chemical reaction in any living and non-living thing based on formation of "molecules". A reaction in the smallest living organism or in the most developed species like man, always takes place through the process of molecule formation. Hence it provides basis of "molecularity" of the physical world.

Q. No. 31 What is the Corpuscular nature of matter?

CORPUSCULAR NATURE OF MATTER.

In 1924 de Broglie put forward. The theory of dual nature of matter i.e. matter has both the properties of particles as well as waves. He explained the background of two ideas. He advocated that these two systems could not remain detached from each other. By mathematical evidences he proved that every moving object is attached with waves and every wave has corpuscular nature as well. It formulated a basis to understand corpuscular nature of matter.

Q. No. 32 Give the services of different scientist for the development of science.

THE WORKS OF DIFFERENT SCIENTISTS AT THE SAME TIME HANDICAP OR PROMOTE THE GROWTH OF SCIENCE.

Over the course of human history, people have developed many interconnected and validated ideas about the physical, biological, psychological, and social worlds. Those ideas have enabled successive generations to achieve an increasingly comprehensive and reliable understanding of the human species and its environment. The means used to develop these ideas are particular ways of observing, thinking, experimenting and validating. These ways represent a fundamental aspect of the nature of science and reflect how science tends to differ from other modes of knowing. It is the union of science, mathematics and technology that forms the scientific endeavor and that makes it so successful. Although each of these human enterprises has a character and history of its own, each is dependent on and reinforces the others.

Example 1.6

Calculate the numbe of moles, number of molecules and number of atoms present in 6 grams of water.

Solution

The known mass of water = 6g

Molar mass of H_20 = 18 g

Number of moles of water = $\frac{\text{known mass of substance}}{\text{molar mass of substance}}$

= 6/18

= 0.33 moles

Number of molecules = number of moles x Avogadro's number

$= 0.33 \times 6.02 \times 10^{23}$

Result $= \mathbf{1.98 \times 10^{23}}$ **molecules**

The number of molecules contained in 6 grams of water are 1.98×10^{23}

As we know I molecule of water consists of 3 atoms, therefore:

Number of atoms $= 3 \times 1.98 \times 10^{23}$

$= 5.94 \times 10^{23}$

Result

Number of molecules $= \mathbf{5.94 \times 10^{23}}$ **molecules**

Example 1.7

There are 3.01×10^{23} molecules of $C0_2$ present in a container. Calculate the nu of moles and its mass.

Solution

We can calculate the number of molecules of CO_2 by putting the values in equation

$$\text{Number of moles of } CO_2 = \frac{\text{Known Molecules}}{\text{Avogadro's Number}}$$

$$\text{Number of moles of } CO_2 = \frac{3.01 \times 10^{23}}{6.02 \times 10^{23}}$$

Number of moles of CO_2 = 0.5

Then by putting this value in this equation we get

Mass of substance = number of moles x molar mass (g)

Mass of CO_2 = 0.5 x 44

Result **= 22g**

EXERCISE

MCQ'S

1. **Industrial chemistry deals with the manufacturing of compounds:**
   (a) in the laboratory (b) on micro scale
   (c) on commercial scale (d) on economic scale
2. **Which one of the following can be separated by physical means?**
   (a) mixture (b) element (c) compound (d) radical
3. **The most abundant element occurring in the oceans is:**
   (a) oxygen (b) hydrogen (c) nitrogen (d) silicon
4. **Which one of the following element is found in most abundance in the earth's crust?**
   (a) oxygen (b) aluminum (c) silicon (d) iron
5. **The third abundant gas found in the earth's crust is:**
   (a) carbon monoxide (b) oxygen. (c) nitrogen (d) argon
6. **One amu (atomic mass unit) is equivalent to:**
   (a) 1.66×10^{-24} mg (b) 1.66×10^{-24}g (c). 1.66×10^{-21}g (d) 1.66×10^{23}g
7. **All of the followings are tri-atomic molecule except:**
   (a) H_2 (b) O_3 (c) H_2O (d) CO_2
8. **The mass of one molecule of water is:**
   (a) 18 amu (b) 18 g (c) 18 mg (d) 18 kg
9. **The molar mass of H_2S0_4 is:**
   (a) 98 g (b) amu (c) .8 g (d) 9.8 amu
10. **Molar mass is usually expressed in grams. Which one of the following is molar mass of O_2 in amu?**
    (a) 32 amu (b) 53.12×10^{-24} amu
    (c) 1.92×10^{-25} amu (d) 192.64×10^{-25} amu
11. **How many numbers of moles are equivalent to 8 grams of CO_2?**
    (a) 0.15 (b) 0.18 (c) 0.21 (d) 0.24
12. **Which one of the following pair has the same number of ions?**
    (a) 1 mole of NaCl and 1 mole of $MgCl_2$ (b) 1/2 mole of NaCl and 1/2 mole of $MgCl_2$
    (c) 1/2 mole of NaCl and 1/3 mole of $MgCl_2$ (d) 1/3 mole of NaCl and 1/2 mole of $MgCl_2$
13. **Which one of the followings pair has the same mass?**
    (a) 1 mole of CO and 1 mole of N_2 (b) 1 mole of CO and 1 mole of CO_2
    (c) 1 mole of O_2 and 1 mole of N_2 (d) 1 mole of O_2 and 1 mole of CO_2

ANSWR KEY

1	c	3	a	5	b	7	a	9	a	11	b	13	a
2	a	4	c	6	b	8	a	10	a	12	c	KIPS	

SHORT QUESTIONS

Q.1 Define industrial c' mistry and analytical chemistry.

Ans:

Industrial Chemistry:

"This branch of chemistry is related to the industrial processes." It is associated with studies of properties uses and application of techniques for the preparation of industrial sales on large scale.

Analytical Chemistry:

"It deals with the detection and estimation of elements and compounds. In this the composition of elements is primarily analyzed."

Q.2 How can you differentiate between organic and inorganic chemistry?

Ans:

Organic Chemistry	Inorganic Chemistry
It is study of the properties and behavior of hydrocarbons (compounds of carbon and hydrogen) and their derivatives.	It is the study of properties and behavior of all elements except the hydrocarbons and their derivatives.

Q.3 Give the scope of biochemistry.

Ans: It is the branch of chemistry in which we study the structure, composition, and chemical reaction of substance found in living organisms. It covers all chemical processes taking place in living organisms. Such as synthesis and metabolism of bio molecules like carbohydrates, proteins and fat. Biochemistry emerged as separate discipline when scientists began to study how living things obtain energy from food or how the fundamental biological changes occur during a disease. Examples of applications of biochemistry are in the fields of medicine, food science and agriculture etc.

Q.4 Wow does homogeneous mixture differ from heterogeneous mixture?

Ans:

Homogeneous Mixture	Heterogeneous Mixture
Mixtures that have uniform composition through are called homogeneous mixtures.	Those mixtures in which composition are not uniform throughout are called heterogeneous mixtures.
For example: Air, gasoline and ice cream	**For example:** Soil, rock and wood.

Q.5 What is the relative atomic mass? How it is related to gram?

Ans: The relative atomic mass of an element is the average mass of atoms of that element as compared to $1/12^{th}$ (one-twelfth) the mass of one atom of carbon-12 isotope (an element having different mass number but same atomic number). The unit for relative atomic masses is called atomic mass unit, with symbol amu. One atomic mass unit is $1/12^{th}$ the mass of one atom of carbon-12^{th}. When this atomic mass unit is expressed in grams it is

$$1 \text{ amu} = 1.66 \times 10^{-24} \text{ g}$$

Q.6 Define empirical formula with example.

Ans: **Empirical Formula:**

It is the simplest whole number ratio of atoms present in a compound. The empirical formula of a compound is determined by knowing the percentage composition of a compound.

Example

Glucose has simplest ratio 1: 2: 1 of carbon, hydrogen and oxygen respectively. Hence its empirical formula is CH_2O.

Q.7 State three reasons why do you think air is a mixture and water a compound?

Ans:

Air (Mixture)	Water (Compound)
• Mixture is formed by the simple mixing up of the substances.	• It is formed by the chemical combination of atoms of elements.
• Air does not have a sharp and fixed melting point.	• Water has a sharp and fixed melting point.
• Air has heterogeneous mixture composition.	• Water has homogeneous composition.

Q.8 Explain why are hydrogen and oxygen considered elements whereas water as a compound.

Ans: Hydrogen and oxygen are elements because they have same type of atoms, having same atomic number and it cannot be decompose into simple substances by chemical means. Water is considered as compound because it is a substance made up of two or more elements chemically combined together in a fixed ratio by mass. As a result of this combination oxygen and hydrogen lose their own properties and produce new substance (H_2O).

Q.9 What is the significance of the symbol of an element?

Ans: Significance of the symbol of an element:

Symbols are used for elements instead of writing of their complete names. So, it takes less time/save time and element can be recognized by that symbol in all over the world.

For example

- Oxygen (O)
- Sulphur (S)
- Nitrogen (N)

Q.10 State the reasons: soft drink is a mixture and water is a compound.

Ans:

Mixture (Soft Drink)	Compound (Water)
• Soft drink is made up of simple mixing up of substance.	• Water is formed by chemical combination of atoms of elements.
• Soft drink has heterogeneous composition.	• Water has homogenous composition.
• Its components can be separated by physical means.	• Water has homogeneous composition.

Q.11 Classify the following into element, compound and mixture:

- **He and H_2**
- **CO and CO_2**
- **Water and milk**
- **Gold and brass**
- **Iron and steel**

Ans:

Element	Compound	Mixture
• Gold	• CO_2 and CO	• Milk
• He	• Water	• Brass
• Iron	• H_2 is a molecule	• Steel

Q.12 Define atomic mass unit. Why is it needed?

Ans: Atomic mass unit

The unit for relative, atomic masses is called atomic mass unit.

Symbol

Its symbol is amu.

One atomic mass unit is 1/12th the mass of one atom of carbon-12th the mass of one atom of carbon-12th. When this atomic mass unit is expressed in grams, it is: **1 amu =1.66×10^{-24} g**

Q.13 State the nature and name of the substance formed by combining the following:

- **Zinc + Copper**
- **Water + Sugar**
- **Aluminium + Sulphur**
- **Iron + Chromium + Nickel**

Ans:

Reactants	Nature & Name	
Zn + Copper	(Mixture)	Brass
Water + Sulphur	(Mixture)	Sugar solution
Aluminium + Sulphur	(Compound)	Aluminium sulphide
Iron + Chromium + Nickel	(Mixture)	Nichrome

Q.14 Differentiate between molecular mass and formula mass, which of the following will be molecular formula?

- **H_2O**
- **NaCl**
- **KI**
- **H_2SO_4**

Ans:

Molecular Mass	Formula Mass
The sum of atomic masses of all the atoms present in one molecule of a molecular compound is its molecular mass.	Formula mass is the sum of atomic masses of all the atoms present in one formula unit of a substance.
For example Molecular mass of water is 18 amu and that of carbon is 44 amu	**For example** Formula mass of sodium chloride is 58.5 amu and that of $CaCO_3$ is 100 amu.

H_2O and H_2SO_4 are the molecular formula.

Q.15 Which has more then atoms: 10 g of *Al* or 10 g of Fe?

Ans: 10 g of Al has more atoms than 10 g of Fe.

For Al

$$\text{Number of atom} = \frac{\text{Mass}}{\text{Molar Mass}} \times N_A$$

$$= \frac{10}{23} \times 6.02 \times 10^{23}$$

$$= 2.617 \times 10^{23}$$

For Fe

$$\text{Number of atom} = \frac{\text{Mass}}{\text{Molar Mass}} \times N_A$$

$$= \frac{10}{56} \times 6.02 \times 10^{23}$$

$$= 1.075 \times 10^{23}$$

Result: **Aluminium has more number of atoms than iron.**

Q.16 Which one has more molecules: 9 g of water or 9 g of sugar ($C_{12}H_{22}O_{11}$)?

Ans: 9 g of water has more molecules than 9 g of sugar because moles of water are more than sugar.

For Water

$$\text{Number of molecules} = \frac{\text{Mass}}{\text{Molar Mass}} \times N_A$$

$$= \frac{9}{18} \times 6.02 \times 10^{23}$$

$$= 3.01 \times 10^{23}$$

For Sugar ($C_6H_{12}O_6$)

$$\text{Number of Molecules} = \frac{\text{Mass}}{\text{Molar Mass}} \times N_A$$

$$= \frac{9}{180} \times 6.02 \times 10^{23}$$

$$= 3.01 \times 10^{22}$$

Result: **9 g of H_2O has more molecules than 9 g of $C_6H_{12}O_6$.**

Q.17 Which one has more formula units: 1 g of NaC*l* or 1 g KC*l*?

Ans: NaCl has more formula units than KC*l*.

For NaC*l*

$$\text{Formula units} = \frac{\text{Mass}}{\text{Formula mass}}$$

$$= \frac{1}{58.5}$$

$$= 0.017$$

For KC*l*

$$\text{Formula units} = \frac{\text{Mass}}{\text{Formula mass}}$$

$$= \frac{1}{67.5}$$

$$= 0.014$$

Result: **NaC*l* has more formula units than KC*l*.**

Q.18 Differentiate between homoatomic and heteroatomic molecules with examples.

Ans:

Homoatomic molecules	Heteroatomic molecules
A molecule containing same type of atoms is called homoatomic molecule.	A molecule consists of different kinds of atoms, it is called as heteroatomic molecule.
For example • H_2 • O_3 • S_8	**For example** • CO_2 • H_2O • NH_3

LONG QUESTIONS

Q.1 Define element and classify the elements with examples

Ans: See topic element and its types.

Q.2 List five characteristics by which compounds can be distinguished from mixtures.

Ans: See topic difference between compound and mixture.

Q.3 Differentiate between the following with examples:

(a) Molecule and gram molecule **(b) Atom and gram atom**

(c) Molecular mass and molar mass **(d) Chemical formula and gram formula**

Ans: See in the chapter and given differences.

Q.4 Mole is SI unit for the amount of a substance. Define it with examples?

Ans: See topic the mole concept.

NUMERICALS

Q.1 Sulphuric acid is the king of chemicals. If you need 5 moles of sulphuric acid for a reaction. How many grams of it will you weigh?

Given Data:

Number of moles of H_2SO_4= 5

Molar mass of H_2SO_4 =

$= (1\times2)+(32\times2)+(16\times4)$

$= 2 + 32 + 64$

$= 98$ g/mol

Required data

Mass of H_2SO_4 = ?

Solution:

Formula:

$$\text{Number of Moles} = \frac{\text{Mass of } H_2SO_4}{\text{Molar mass of } H_2SO_4}$$

$$5 = \frac{\text{Mass of } H_2SO_4}{98}$$

$$5 \times 98 = \text{Mass of } H_2SO_4$$

Result: **Mass of H_2SO_4 = 490g**

Q.2 ***Calcium carbonate is insoluble in water. If you have 40 g of it; how m~ Ca^{2+} and CO_3^{2-} ions are present in it?***

Given Data:

Mass of calciumcarbonate = 40g

Formula of Calcium Carbonate = $CaCO_3$

Molar mass of calcium carbonate = $CaCO_3$

$= (40\times1) + (12\times1)+(16\times3)$

$= 40 + 12 + 48$

$= 100$ g/mol

Required data

Number of Ions of

Ca^{+2} & CO_3^{-2} = ?

Solution:

Number of Moles of $CaCO_3$ = $\frac{\text{Mass of } CaCO_3}{\text{Molar mass of } CaCO_3}$

$= \frac{40}{100}$

Number of moles of $CaCO_3$ = 0.4 mole

Number of moles of Ca^{+2} ions in one mole of $CaCO_3$ $= 6.02 \times 10^{23}$

Number of Ca+2 ion in 0.4 moles of $CaCO_3$ $= 6.02 \times 10^{23} \times 0.4$

$= 2.408 \times 10^{23}$ ions

Number of ions of CO_3^{-2} in 1 mole of $CaCO_3$ $= 6.02 \times 10^{23}$

Number of ions of CO_3^{-2} in 0.4 moles of $CaCO_3$ $= 6.02 \times 10^{23} \times 0.4$

Result $\mathbf{= 2.408 \times 10^{23}}$ **ions**

Q.3 If you have 6.02×10^{23} ions of aluminium; how many sulphate ions will be required to prepare $Al_2(SO_4)_3$?

Given Data:

Number of ionsof Al^{+3} $= 6.02 \times 10^{23}$

Formula of Aluminium Sulphate $= Al_2(SO_4)_3$

Number of sulphate ions in $Al_2(SO_4)_3$ = 3

$= 6.02 \times 10^{23} \times 3$

$= 18.06 \times 10^{23}$

$= 1.806 \times 10^{24}$ ions

A number of aluminium in $Al_2(SO_4)_3$ = 2

Number of Sulphate ions $= \frac{1.806 \times 10^{24}}{2}$

$= .903 \times 10^{24}$

Reusit $\mathbf{= 9.03 \times 10^{23}}$

Q.4 Calculate the number of molecules of the following compounds:

(a) 16 g of H_2CO_3 **(b) 20 g of HNO_3** **(c) 30 g of $C_6H_{12}O_6$**

Given Data:

16g of H_2CO_3

Given mass of H_2CO_3 = 16g

Molar mass of H_2CO_3 $= (2\times1) + (1\times12) + (3\times16)$

$= 2 + 12 + 48$

$= 62 g / mol$

Number of moles of H_2CO_3 = ?

Number of moles of H_2CO_3 $= \frac{\text{Givenmass of } H_2CO_3}{\text{Molar mass of } H_2CO_3}$

$= \frac{16}{62} = 0.25$ mol

Number of molecules in one moles of H_2CO_3 $= 6.02 \times 10^{23}$

Number of molecules in 0.25 moles of H_2CO_3 $= 6.02 \times 10^{23} \times 0.25$

Result $\mathbf{= 1.505 \times 10^{23}}$

(b) **20g of HNO_3**

Given data:

Given mass of HNO_3 = 20gms

Molar mass of HNO3 = $(1\times1) + (1\times14) + (16\times3)$

= 1+14+48=63g/mol

No. of moles of HNO_3 $= \frac{\text{Given mass of } HNO_3}{\text{Molar mass of } HNO_3}$

$= \frac{20}{63}$

= 0.317 mol.

No. of molecules in one mole = $0.317 \times 6.02 \times 10^{23}$

Result = **1.908×10^{23} molecules**

(c) **30g of $C_6 H_{12} O_6$**

Given data:

Given mass of $C_6H_{12}O_6$ = 30g.

Molar mass of $C_6 H_{12} O_6$ = 72 + 12 + 96

= 180g / mol

No. of moles of C6H12O6 $= \frac{\text{Given mass of } C_6H_{12}O_6}{\text{Molar mass of } C_6H12O_6}$

$= \frac{30}{180} = 0.16$ mol

No. of molecules in one mole of $C_6H_{12}O_6$ = 6.02×10^{23}

No. of molecules in 0.16 moles of $C_6H_{12}O_6$ = $6.02 \times 10^{23} \times 0.16$

= 0.96×10^{23}

Result = **9.6×10^{22} molecules**

Q.5 Calculate the number of ions in the following compounds:

(a) 109 of $AlCl_3$ **(b) 30 g of $BaCl_2$** **(c) 58 g of H_2S0_4**

Given Data:

Given mass of $AlCl_3$ = 10g

Molar mass of $AlCl_3$ = 27 + 35.5 × 3

= 133.5 g / mol

No. of moles of $AlCl_3$ = $\frac{\text{Givenmass of } AlCl_3}{\text{Molar mass of } AlCl_3}$

$= \frac{10}{133.5}$

= 0.074 mol

No. of Al^{+3} ion in one mole = 6.02×10^{23}

No. of Al^{-3} on in 0.074 moles= $6.02 \times 10^{23} \times 0.074$

= 0.450×10^{23}

No. of Cl^{-1} ions in 1mole = 6.02×10^{23}

No. of Cl^{-1} ions in 0.074 moles = $6.02 \times 10^{23} \times 0.074$

= 0.450×10^{23}

3 ions of Cl^{-1} = $0.450 \times 10^{23} \times 3$

Result = **1.35×10^{23} ions**

(b) **30g of $BaCl_2$**

Given Data:

Given mass of $BaCl_2$ = 30g

Molar mass of $BaCl_2$ = 137 + 35.5 × 2

= 208g / mol

No. of moles of $BaCl_2$ = $\frac{\text{Givenmass of } BaCl_2}{\text{Molar mass of } BaCl_2}$

= $\frac{30}{208}$

= .144 mol

No. of Ba^{2+} ion in one mole = 6.02×10^{23}

No. of Ba^{2+} on in 0.144 moles = $6.02 \times 10^{23} \times 0.144$

= 0.866×10^{23}

No. of Cl^{-1} ions in 1mole = 6.02×10^{23}

No. of Cl^{-1} ions in 0.144 moles = $6.02 \times 10^{23} \times 0.144$

= $.866 \times 10^{23}$

2 ions of Cl^{-1} = $0.450 \times 10^{23} \times 2$

Result = **1.733×10^{23}**

(c) **58g of H_2SO_4**

Given Data:

Given mass of H_2SO_4 = 58g

Molar mass of H_2SO_4 = 1×2+32×1+16×4

= 98 g / mol

No. of moles of H_2SO_4 = $\frac{\text{Givenmass of } H_2SO_4}{\text{Molar mass of } H_2SO_4}$

= $\frac{58}{98}$

= 0.591 mol

No. of H^{1+} ion in one mole = 6.02×10^{23}

No. of H^{1+} on in 0.591 moles = $6.02 \times 10^{23} \times 0.591$

= 3.56×10^{23}

2 ions of H^{1+} = $3.56 \times 10^{23} \times 2$

= 7.125×10^{23}

No. of SO_4^{2-} ions in one mole = 6.02×10^{23}

No. of SO_4^{2-} ions in .591 moles = $6.02 \times 10^{23} \times .591$

Result = **3.56×10^{23}**

Q.6 What will be the mass of 2.05×10^{16} molecules of H_2SO_4

Given Data:

Number of molecules of H_2SO_4 = 2.05×10^{16}

Number of molecules in one mole of H_2SO_4 = 6.02×10^{23}

Molar mass of H_2SO_4 = 98g.

Mass of H_2SO_4 = ?

No. of moles of H_2SO_4 = ?

Solution:

Number of moles of H_2SO_4 $= \dfrac{\text{No. of molecules of } H_2SO_4}{N_A}$

$= \dfrac{2.05\times10^{16}}{6.02\times10^{23}}$

$= 0.340\times10^{16-23}$

$= 0.34\times10^{-7}$

Number of moles of H_2SO_4 $= \dfrac{\text{Molecularmass of } H_2SO_4}{\text{Molar mass}}$

Molecular mass of H_2SO_4 = Number of moles × molar mass

$= 0.34\times10^{-7}\times98$

Result $= \mathbf{3.332\times10^{-6}g}$

Q.7 How many total atoms are required to prepare 60 g of HNO_3?

Given Data:

Given mass of HNO_3 = 60g

Molar mass of HNO_3 $= 1\times1+14\times1+16\times3$

$= 1+14+48$

$= 63g/mol$

Number of moles of HNO_3 $= \dfrac{\text{Given mass of } HNO_3}{\text{Molarmass of } HNO_3}$

$= \dfrac{60}{63}$

= 0.95 moles

Number of moles of HNO_3 = Na × moles of HNO_3

$= 6.02\times10^{23}\times0.95$

$= 5.7\times10^{23}$ molecules

One molecule of HNO_3 contain 5 atoms =

No of atoms $= 5\times5.7\times10^{23}$

$= 28.5\times10^{23}$

Result $= \mathbf{2.85\times10^{24}}$ **atoms**

Q.8 How many ions of Na^+ and Cl^{-1} will be present in 30 g of N aCl?

Given Data:

Given mass of NaCl = 30g

Molar mass of NaCl $= 23\times1+35.5\times1$

$= 23+35.5$

$= 58.5g/mol$

Number of moles of NaCl $= \dfrac{\text{Given mass of NaCl}}{\text{Molar mass of NaCl}}$

$= \dfrac{30}{56.5}$

= 0.59 moles

Number of Na^+ and Cl^{-1} ions one mole of NaCl $= (6.02\times10^{23}) + (6.02\times10^{23})$

$= 1.204\times10^{24}$

Number of Na^+ and Cl^{-1} in 0.51 moles of NaCl $= 1.204\times10^{24}\times0.51$

$= 0.617\times10^{24}$

Result $= \mathbf{6.17\times10^{23}}$

Q.9 How many molecules of HCl will be required to have 10 grams of it?

Given mass of HCl = 10g

Molar mass of HCl = 1×1+35.5+1

= 36.5g / mol

$$\text{Number of moles of HCl} = \frac{\text{Given mass of HCl}}{\text{Molar mass of HCl}}$$

$$= \frac{10}{36.5}$$

= 0.27 mol

Number of molecules of HCl = N_A × Number of moles of HCl

$= 6.02 \times 10^{23} \times 0.27$

Result $= 1.64 \times 10^{23}$

Q.10 How many grams of Mg will have the same number of atoms as 6 grams of C have?

Given data

Given mass of carbon = 6g

Atomic mass of carbon = 12g

Atomic mass of Mg = 24g

Required data

No. of carbon atoms = ?

No. of Mg atoms = ?

Mass of Mg = ?

Solution:

$$\text{No. of moles of carbon} = \frac{\text{Given mass of Carbon}}{\text{Molar mass of Carbon}}$$

$$= \frac{6}{12}$$

= 0.5 mol

Number of carbon atoms in 1 mole $= 6.02\times10^{23}$

Number of carbon atoms in 0.5 mole $= 6.02\times10^{23} \times 0.5$

$= 3.01 \times 10^{23}$

According to the question the no. of atoms of mg and carbon is same, so, its no. of moles are also equal.

No. of moles of Mg = 0.5 moles

$$\text{No. of moles of Mg} = \frac{\text{Given mass of Mg}}{\text{Molar mass of Mg}}$$

Given mass of Mg = No. of moles of Mg × molar mass of Mg

= 0.5 × 24

Result = 12g

Note: So the 6 gm of carbon and 12 gm of Mg have same number of atoms

SHORT QUESTIONS

Q.1 Define industrial c' mistry and analytical chemistry.

Ans:

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Ans: The relative atomic mass of an element is the average mass of atoms of that element as compared to $1/12^{th}$ (one-twelfth) the mass of one atom of carbon-12 isotope (an element having different mass number but same atomic number). The unit for relative atomic masses is called atomic mass unit, with symbol amu. One atomic mass unit is $1/12^{th}$ the mass of one atom of carbon-12^{th}. When this atomic mass unit is expressed in grams it is

$$1 \text{ amu} = 1.66 \times 10^{-24} \text{ g}$$

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Glucose has simplest ratio 1: 2: 1 of carbon, hydrogen and oxygen respectively. Hence its empirical formula is CH_2O.

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Ans:

Air (Mixture)	Water (Compound)
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• Air does not have a sharp and fixed melting point.	• Water has a sharp and fixed melting point.
• Air has heterogeneous mixture composition.	• Water has homogeneous composition.

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Q.9 What is the significance of the symbol of an element?

Ans: Significance of the symbol of an element:

Symbols are used for elements instead of writing of their complete names. So, it takes less time/save time and element can be recognized by that symbol in all over the world.

For example

- Oxygen (O)
- Sulphur (S)
- Nitrogen (N)

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Ans:

Mixture (Soft Drink)	Compound (Water)
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• Soft drink has heterogeneous composition.	• Water has homogenous composition.
• Its components can be separated by physical means.	• Water has homogeneous composition.

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- **He and H_2**
- **CO and CO_2**
- **Water and milk**
- **Gold and brass**
- **Iron and steel**

Ans:

Element	Compound	Mixture
• Gold • He • Iron	• CO_2 and CO • Water • H_2 is a molecule	• Milk • Brass • Steel

Q.12 Define atomic mass unit. Why is it needed?

Ans: Atomic mass unit

The unit for relative, atomic masses is called atomic mass unit.

Symbol

Its symbol is amu.

One atomic mass unit is 1/12th the mass of one atom of carbon-12th the mass of one atom of carbon-12th. When this atomic mass unit is expressed in grams, it is: **$1 \text{ amu} = 1.66 \times 10^{-24}$ g**

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- **Zinc + Copper**
- **Water + Sugar**
- **Aluminium + Sulphur**
- **Iron + Chromium + Nickel**

Ans:

Reactants	Nature & Name	
Zn + Copper	(Mixture)	Brass
Water + Sulphur	(Mixture)	Sugar solution
Aluminium + Sulphur	(Compound)	Aluminium sulphide
Iron + Chromium + Nickel	(Mixture)	Nichrome

Q.14 Differentiate between molecular mass and formula mass, which of the following will be molecular formula?

- **H_2O**
- **NaCl**
- **KI**
- **H_2SO_4**

Ans:

Molecular Mass	Formula Mass
The sum of atomic masses of all the atoms present in one molecule of a molecular compound is its molecular mass.	Formula mass is the sum of atomic masses of all the atoms present in one formula unit of a substance.
For example Molecular mass of water is 18 amu and that of carbon is 44 amu	**For example** Formula mass of sodium chloride is 58.5 amu and that of $CaCO_3$ is 100 amu.

H_2O and H_2SO_4 are the molecular formula.

Q.15 Which has more then atoms: 10 g of *Al* or 10 g of Fe?

Ans: 10 g of Al has more atoms than 10 g of Fe.

For Al

$$\text{Number of atom} = \frac{\text{Mass}}{\text{Molar Mass}} \times N_A$$

$$= \frac{10}{23} \times 6.02 \times 10^{23}$$

$$= 2.617 \times 10^{23}$$

For Fe

$$\text{Number of atom} = \frac{\text{Mass}}{\text{Molar Mass}} \times N_A$$

$$= \frac{10}{56} \times 6.02 \times 10^{23}$$

$$= 1.075 \times 10^{23}$$

Result: Aluminium has more number of atoms than iron.

Q.16 Which one has more molecules: 9 g of water or 9 g of sugar ($C_{12}H_{22}O_{11}$)?

Ans: 9 g of water has more molecules than 9 g of sugar because moles of water are more than sugar.

For Water

$$\text{Number of molecules} = \frac{\text{Mass}}{\text{Molar Mass}} \times N_A$$

$$= \frac{9}{18} \times 6.02 \times 10^{23}$$

$$= 3.01 \times 10^{23}$$

For Sugar ($C_6H_{12}O_6$)

$$\text{Number of Molecules} = \frac{\text{Mass}}{\text{Molar Mass}} \times N_A$$

$$= \frac{9}{180} \times 6.02 \times 10^{23}$$

$$= 3.01 \times 10^{22}$$

Result: **9 g of H_2O has more molecules than 9 g of $C_6H_{12}O_6$.**

Q.17 Which one has more formula units: 1 g of Na*Cl* or 1 g K*Cl*?

Ans: NaCl has more formula units than K*Cl*.

For Na*Cl*

$$\text{Formula units} = \frac{\text{Mass}}{\text{Formula mass}}$$

$$= \frac{1}{58.5}$$

$$= 0.017$$

For K*Cl*

$$\text{Formula units} = \frac{\text{Mass}}{\text{Formula mass}}$$

$$= \frac{1}{67.5}$$

$$= 0.014$$

Result: **Na*Cl* has more formula units than K*Cl*.**

Q.18 Differentiate between homoatomic and heteroatomic molecules with examples.

Ans:

Homoatomic molecules	Heteroatomic molecules
A molecule containing same type of atoms is called homoatomic molecule.	A molecule consists of different kinds of atoms, it is called as heteroatomic molecule.
For example • H_2 • O_3 • S_8	**For example** • CO_2 • H_2O • NH_3